(*b*) Investigations with the object of effecting some modifications in the details of an existing process whereby it shall become technically and commercially more efficient.

(*c*) Investigations with the object of converting a scientific discovery (or results which may be predicated from research in pure science) into a useful scientific invention.

(4) Whilst all the above three classes of research are, or should be, essential features in any organised scheme for the benefit of trade and industry, the third class is undoubtedly, not only the most important of all, but also the one which presents the greatest executive difficulties in procedure, and unless at the outset these difficulties are both clearly recognised and equitably met, the complete success of the scheme will be seriously jeopardised.

(5) It ought to be recognised in principle that an individual scientific investigator who may seek or obtain assistance from the central national research fund should be accorded the fullest credit and protection for the ideas which he may disclose, as also direct personal access (without having to invoke the aid or interest of some intermediary person or association) to the Advisory Council or Committee (or persons representing them) administering the fund. Furthermore, if the ideas or discoveries disclosed by him are deemed important and worthy of support, as likely to result in a useful invention, not only should the further investigation of the matter be entrusted to his unhampered direction, but also, in the event of such further investigation under his direction ultimately resulting in a useful invention, his rights and interests in the commercial results of such invention should be equitably provided for and ensured.

To the objection which may be made that the acceptance by a scientific worker of assistance from a public fund for the development of his ideas or discoveries implies forfeiture on his part of any pecuniary advantage which would otherwise accrue to him, it may be replied that a scientific worker ought not to be put into a worse position in regard to the development of his discoveries, merely because he is financially assisted by the State, than he would have been had he been financed privately. It is a just and necessary principle in the development of inventions, no matter whether such development is financed by the State or by some private person or syndicate, that the inventor *qua* inventor is as much entitled in equity to a reasonable interest in the commercial results of his ideas as is the financial power that he may invoke, and unless such principle is conceded at the outset in connection with the Government scheme, it will never attract, or be invoked by, the scientific inventor for the development of his ideas. In short, invention and discovery, being essentially "individualistic" products, cannot flourish or be fully developed on a "socialistic" basis; and in every State-aided scheme there lurks the socialistic danger.

(6) If the above principle be conceded, there are doubtless formidable difficulties in carrying it out. Thus, for instance, it will be necessary to provide that the communication of an idea or discovery of an individual or group of individual scientific workers to an Advisory Board must not merely be *confidential,* but shall also confer the same sort of *provisional protection* which the lodging of a provisional specification at the Patent Office now confers. In the second place, should the further State-aided investigation of the matter result in a useful invention, not only ought the resources of the British Patent Office to be placed freely at the disposal of the inventor for the adequate protection of his invention, but also steps would have to be taken to ensure the same protection in all important foreign countries. For unless this were done, foreign manufacturers and countries would reap the reward of British scientific invention financed by the British taxpayer, without having to pay so much as a single halfpenny by way of royalties to the British people, and Great Britain would for ever sacrifice a most fruitful source of "invisible exports" in the shape of "British inventions."

Moreover, it might easily happen that an idea or invention originating in Britain, under a Government scheme without due safeguards, might be freely imported into Germany, and through German sources be patented in other countries for the benefit of Germany; such things have happened in the past under the existing patent laws, and will happen all the more in future, if the new scheme does not fully protect British scientific inventions. There thus lurks in the new scheme the serious danger of its proving an instrument and organisation whereby British brains and capital will be exploited largely for the benefit of the foreigner, and whilst such danger may perhaps be minimised by wise foresight, it is inherent in the scheme, and it is difficult to see how it can be entirely eliminated.

(7) The foregoing considerations do not, of course, apply to the first of the three classes of investigations cited in section 3 hereof, but unless they are frankly recognised and fully met at the outset, the utility of the scheme in regard to the important third class of investigation will be nullified.

The above suggestions are offered as an individual expression of opinion, which is the outcome of the writer's experience in connection with the development of his own inventions, in the hope that the final scheme will be so framed and safeguarded, in the common interests both of scientific invention and of the British public, that it may be of the utmost benefit to all concerned. WILLIAM A. BONE.

Imperial College of Science and Technology,
London, November 2.

Science in National Affairs.

WHILE the leading article in NATURE of October 21 under the above title must meet with general approval on the part of men of science, there are one or two remarks to which I feel it my duty to direct attention in the interest of science at the present time, so far as it appears to me.

The "Scheme for the Organisation and Development of Scientific and Industrial Research," as issued in a White Paper by the Board of Education, should be carefully considered by us all. I may say that there is very good reason to believe that the gentlemen named in the article in NATURE, Mr. Arthur Henderson, Sir A. Selby-Bigge, and Dr. H. F. Heath, although their chief interests may be in "other fields than those of science," are nevertheless sincerely desirous of improvement in the position of scientific research in this country. If this is so, it is surely our duty, as well as interest, as men of science, to assist so far as we possibly can in what is undoubtedly a new opportunity. There is no doubt that the administrative chairman, Sir Wm. M'Cormick, will gladly welcome suggestions made with the intention of helping the scheme.

I would point out that the Advisory Council, which has the control of the way in which money is to be spent, consists entirely, with the exception of the chairman above named, of well-known and honoured men of science. It may probably be found necessary to place on this Council representatives of biological

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science, but this is a detail, and could be done at a later date.

Whatever may be our views as to a democratic constitution, it must be remembered that it exists, and nothing but obstruction is likely to result from throwing stones at it. It is to be feared that what feeling of opposition to science is present in the democratic mind is largely due to the arrogance apt to be shown by men of science. Skill and success in a particular branch of science alone do not warrant the demand that their possessor shall be regarded as capable of expressing opinions of value on any and all questions of public importance. The same may be said, of course, of any branch of learning. But it can scarcely be held that men of science, as such, have hitherto shown an especially great capacity for business or administrative ability; perhaps it may be because opportunity has been wanting.

We must also confess that ignorance of, or want of interest in, branches of knowledge outside their own domain is not exclusively confined to men of a literary or legal training. At the same time, it may, I think, be reasonably asserted that a wide outlook is more common amongst men of science than amongst other members of the community.

May I suggest that a more conciliatory attitude than that too often assumed with respect to what seem to be well-meant efforts on the part of Government Departments would be more to our interest and for the benefit of the nation? There is, no doubt, a very great deal yet to be done in connection with the position of science in the State. But we may do much in assisting those who are inclined to look with favour on our desires and demands, although it may be that too many of the positions of authority are filled by men lacking in appreciation of the meaning and aims of science. We have an opportunity of showing our value to the nation, and, if we use it well, greater duties and responsibilities will follow.

W. M. BAYLISS.

University College, London, October 23.

[WE do not doubt for a moment that the gentlemen mentioned by Prof. Bayliss take a sympathetic interest in the promotion of scientific research, but this can scarcely be regarded as specially enabling them to administer a scheme to promote the co-ordination of science and industry. What we particularly object to is the assumption, made in all Government offices, that men without scientific knowledge are alone capable of controlling scientific departments and committees. The executive officers of the Committee and Advisory Council on Scientific and Industrial Research represent only one illustration of a principle for which there is no substantial basis. Prof. Bayliss seems disposed to concede this principle: we are not. He suggests that men of science do not possess much business or administrative capacity: we do not accept this generalisation; and we hold that they could scarcely be less effective and less enterprising than administrators trained in unscientific schools. No one supposes that skill and success in science give authority to opinions expressed on other subjects, but neither does work in literary and legal fields create ability to deal with the practical problems of science and technology. Science has too long been content to occupy a subordinate position in the national executive; and the main object of our article was to assert its claims to a higher place.—ED. NATURE.]

A New X-Ray Technique.

THE remarkable therapeutic action of radiations with a range of wave-length from $3{\cdot}8\times10^{-5}$ cm. to $0{\cdot}99\times10^{-9}$ cm. is now generally known and recognised by the medical profession. Between the limits $\lambda=1{\cdot}72\times10^{-9}$ cm., the shortest wave emitted by a Coolidge tube, and $\lambda=0{\cdot}99\times10^{-9}$ cm., the length of the waves of gamma rays from radium C, there is a gap which has so far defied all attempts at bridging.

Meanwhile, physico-physiological laboratories have their hands full with many problems concerning the action of the numerous radiations already available. Research work in this direction can only progress slowly; far more slowly, in fact, than investigations undertaken in perhaps any other branch of physics. But the prospect of final success, and in any case the task of alleviating sickness and pain, is so compelling that he who attacks this problem in the true spirit of science is unconscious of any sacrifice.

Now the various strong inducements presented to the physician by this new method of treatment have led to the hasty accumulation of a large number of facts and a mass of data which serve at the present time as the basis of modern X-ray technique. In the absence so far of any wide generalisation emanating from laboratory work, this necessary knowledge has been largely acquired by the elementary process of trial and error.

I wish, however, to refer here only to that part of the subject which relates to the treatment of deeply-seated tumours and to point out that so astonishing, both as regards action and inaction, are many of the results of treatment by this pleasant and painless means that it is very desirable to pursue the matter as systematically as possible. From the outset, the physician has met with the difficulty of administering a large dose of radiation to an internal region of the body without endangering the more superficial tissues. It has hitherto been usual, therefore, to make comparatively short exposures, taking care at the same time that the intervals between them be not too brief. In order to obviate this drawback the method of "crossfire" has been largely developed on the Continent, the patient being mapped out into several definite areas and the exposures made through several "ports of entry," with the rays always pointing towards the seat of disease.

It occurred, however, to the writer some months ago that by a suitable means of rotating a single X-ray tube and screening off with lead the rays from it, except a comparatively small pencil of them, it would be possible to bring to bear upon a deeply-seated region in the body a far greater amount of radiant energy in a given time than existed at the skin surface during treatment. Intensity of radiation is defined as the energy falling upon one square centimetre of receiving surface, and it is clear that if a conical beam of X-rays could be sent towards a diseased region so that the apex of the cone rested upon the neoplasm, the intensity of radiation there would be far greater than at the skin surface, where the area traversed by the rays is larger. But this would involve a source of rays consisting of a beam of large cross-section and the ability to concentrate it to a focus, the former condition being difficult to obtain and the latter impossible.

Nevertheless, since time enters into the question in the case of therapeutic action it is possible to approximate to the above conditions by the simple device of attaching the X-ray bulb to the circumference of a slowly revolving wheel of about 18 in. diameter, and with its axis pointing towards the diseased region. The screen is arranged to give a slanting beam that makes a convenient angle with the axis of rotation. Thus a hollow cone is swept out by the revolving pencil of rays, and it becomes possible to give a dose of radiation to a deeply-seated tumour ten or more times as great as that received by the skin. In this

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